

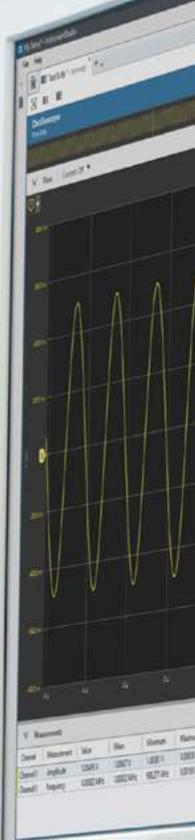
---

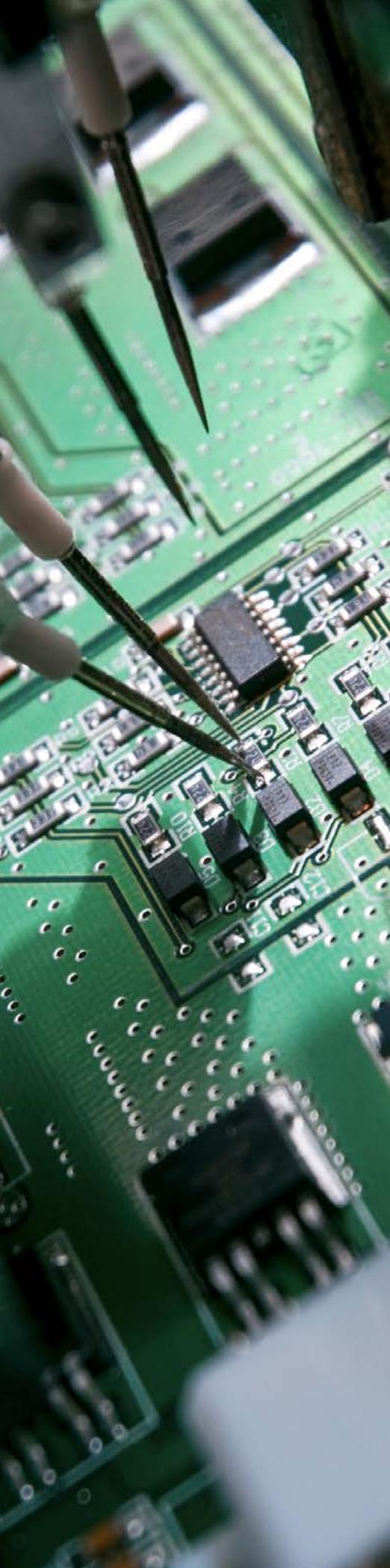
SOLUTION  
BROCHURE

ni.com



# Electronics Manufacturing Test for Aerospace and Defense





# Explore NI's Solutions

Reduce the cost and risk associated with developing and maintaining automated test sets (ATSs) that must last the life cycle of your test system. Future-proof your software architecture by accounting for the inevitability of instrumentation obsolescence. NI's solution for ATS and test program set (TPS) development scales to meet your current and future electronic needs.

## 03 ELECTRONICS MANUFACTURING TEST SOLUTION OVERVIEW

## 04 BOARD ELECTRONICS TEST

Fixturing

Featured Partner: Circuit Check

## 06 LRU AND SYSTEM CONTROLLER TEST

Mass Interconnect

Featured Partner: Virginia Panel Corporation

## 08 POWER ELECTRONICS TEST

Case Study: Collins Aerospace Selects NH Research Test Solutions for The Grid Electric Power Systems Lab

## 10 ELECTRONICS MANUFACTURING TEST HARDWARE

Analog

Digital

Power, Loads, and Signal Conditioning

## 14 SOFTWARE ARCHITECTURE FOR ELECTRONICS MANUFACTURING TEST

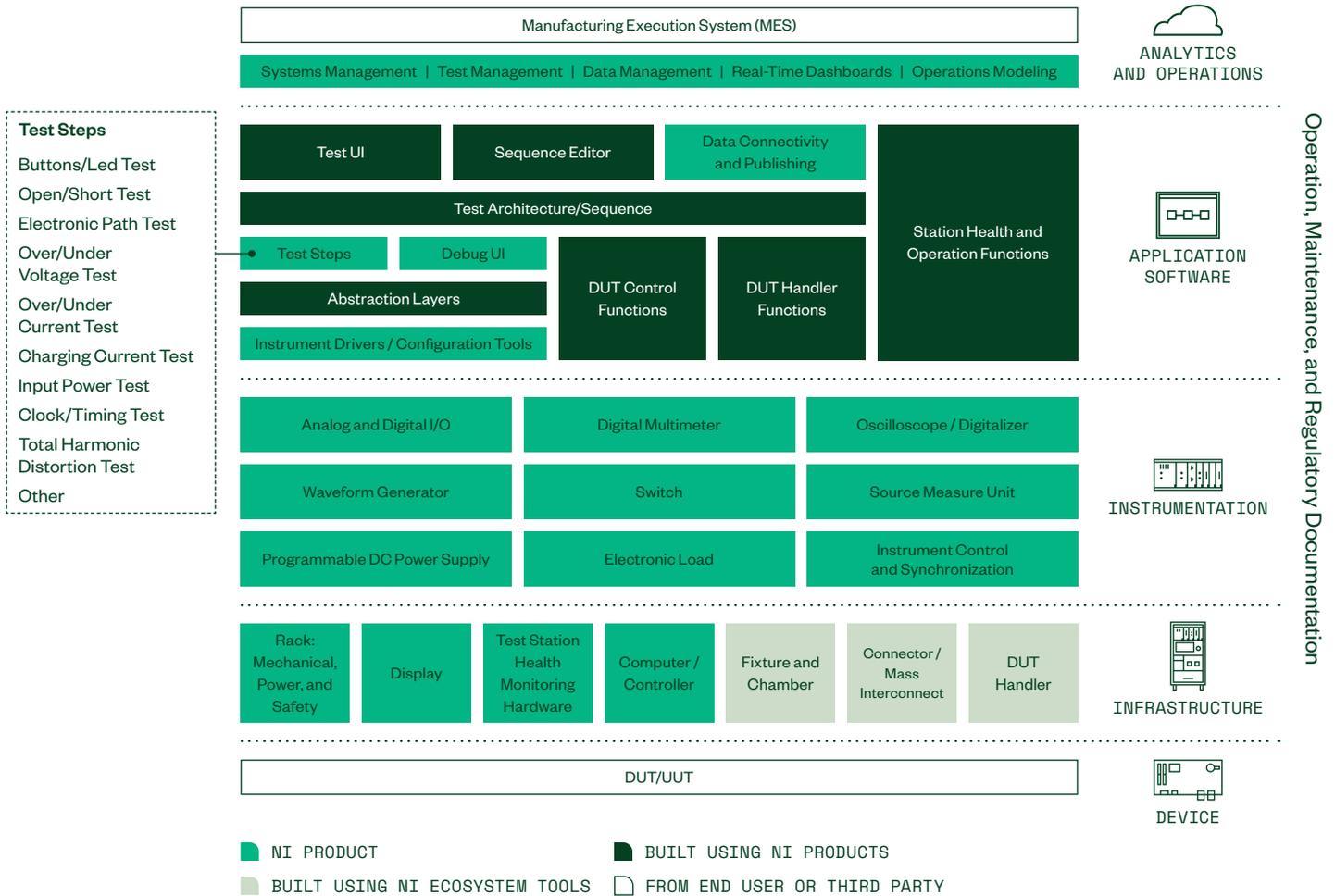
Instrument-Specific Drivers and APIs

LabVIEW

TestStand

SystemLink

# Electronics Manufacturing Test Solution Overview



**FIGURE 01**  
Key Hardware and Software Components for an Electronics Manufacturing Automated Test Set

## NI Solution

- 01** Use off-the-shelf application software that provides a higher-level test starting point
- 02** Develop custom software with support of modern programming environments, including LabVIEW, C, C#, and Python
- 03** Monitor and interactively debug system errors using InstrumentStudio™ software
- 04** Create deployment packages, manage system configurations, streamline data aggregation and insight, and connect to MESs using SystemLink™ software

# Board Electronics Test

Raw printed circuit boards and card assemblies that make up the functional and instrumentation systems in aircraft, vehicles, vessels, satellites, and weapons systems require extensive testing before they're integrated into flight and mission hardware. When testing board electronics, we primarily focus on the electrical measurements required to perform parametric and functional tests to determine manufacturing quality and meet key specifications.

## Customer Needs

### 01

High-mix, low-volume test with a wide variety of signal types

### 02

Interfacing with DUTs through standards-based physical interfaces such as VPX and PCI Express, as well as software protocols including Serial RapidIO® and ARINC 818

### 03

Scaling test system development to grow capacity with increasingly more complex designs and gaining leverage from program to program

## NI Solution

### 01

More than 600 different PXI modules ranging from DC to mmWave

### 02

In addition to traditional instrumentation, NI offers digital avionics interfaces—both directly and through our network of partners for generic, high-speed/backbone, and application-specific protocols

### 03

Improved capital and personnel efficiency and mitigated risk to project schedule by ensuring the right resources are in place

Our Automated Test Engineering Team was able to achieve up to 60 percent code reuse for each automated test and reduce overall test development time by up to 9X. Using the NI certification program, coupled with in-house training, we were able to develop the skills necessary to produce robust, flexible code and maintain it across more than 200 test benches.

L3 Technologies

# Fixturing

Functional and parametric test applies full operational power to a loaded PCBA to determine whether it operates as designed. Most test stations require custom-built test equipment and custom test fixturing. Fixture architecture depends on product volume and the frequency with which you change the model of DUT being tested. Fixtures represent a significant capital expenditure, but because connectivity in the fixture is a leading cause of false failures, best practice dictates that this is not a test system element on which to compromise quality. For high-mix, low-volume situations, you can use personalized drop-in plates within the fixture to minimize capital expense over time. NI partners with trusted fixture vendors across the world, as experienced fixture manufacture is crucial for mechanically durable and ergonomic functionality.

## Featured Partner: Circuit Check

Circuit Check is a leading provider of automated test systems and interfacing solutions with more than 40 years of experience building complete test systems for complex applications. Circuit Check partners with development teams to eliminate potential test risks and ensure the test system is built with the highest quality and reliability. They adhere to the Controlled Goods Program and are ITAR-registered.

### Expertise and Benefits

#### Build-to-Print Partner

Circuit Check partners with customers for build-to-print racks and includes a detailed documentation review and update. Circuit Check designs and fabricates self-test fixtures that come with software necessary to verify proper test-system operation.

#### Design Services

Circuit Check's Test System Engineering Team provides full turnkey automated test solutions for electronic and RF/wireless products in aerospace and defense applications. They provide testability (DFT) consulting, requirements specification development, design, fabrication, system integration, installation, startup support, and sustaining services. Their experienced project managers, engineers, and technical staff work directly with you to ensure a successful project.

#### Quality, Reliability, and Safety

Test-system quality, reliability, and safety are top priority. Circuit Check projects include specification development following an ISO 9001-compliant design process that defines intended uses, design requirements, and the overall test system plan, providing documented traceability from requirement to result.

#### Existing Test-Equipment Update

While programs often are required to run for decades, off-the-shelf test equipment was not designed with this in mind. Obsolescence is a seemingly never-ending battle that Circuit Check can help you win. We specialize in taking older, obsolete test systems and bringing them into the present with a design that makes future test equipment obsolescence much easier to overcome.

---

#### KEY CAPABILITIES

- Full turnkey test development for all forms of analog and digital electronics from DC to mmWave
- Self-test fixtures
- Complex ITAs
- Software capabilities including LabVIEW, TestStand, C#, CCI Test (VB.NET)
- HAL and MAL software architecture development
- Full acceptance testing
- Functional fixture testing
- Test system modernization
- Build to print



# LRU and System Controller Test

Every aerospace and defense vehicle, aircraft, and asset relies on up to hundreds of electrical subsystems that must work in perfect unison. From cockpit displays to full fly-by-wire systems, these components must be put through a barrage of functional tests to ensure reliable operation across all mission scenarios. As these subsystems evolve to meet the needs of future missions, so, too, must design and test.



## Customer Needs

- 01** Managing test capability to meet the life-cycle needs of the DUT
- 02** Integrating equipment from multiple vendors, particularly for digital interfaces
- 03** Scaling test capability across a variety of DUT families and types

## NI Solution

- 01** NI offers a software-connected approach with built-in measurement abstraction and modular hardware for a more scalable solution
- 02** PXI is an open industry standard, with nearly 1,500 products available from more than 70 different instrument vendors
- 03** You can adapt to various I/O types with integrated signal conditioning and switching through NI Switch Load and Signal Conditioning (SLSC)

The innovative LM-STAR approach to standardized test system development based on COTS software has yielded many cost-saving benefits for [Lockheed Martin], harmonization suppliers, and the US government.

**Robert Dixon**  
Lockheed Martin STS

# Mass Interconnect

An interconnect solution interfaces the test instrument(s) and unit(s) under test. Consolidating multiple test resources, interconnect solutions are available in multiple sizes and configurations to accommodate virtually any testing requirement.

## Featured Partner: Virginia Panel Corporation

Virginia Panel Corporation (VPC) solutions accommodate a wide array of ATE chassis sizes/configurations, providing a reconfigurable and scalable solution. VPC's solutions offer modular flexibility and address a wide range of signal, power, coaxial, and pneumatic I/O requirements. VPC is known for their high-performance cable assemblies and patchcords which produce quality connections and contribute to an overall high-quality and reliable mass interconnect solution.

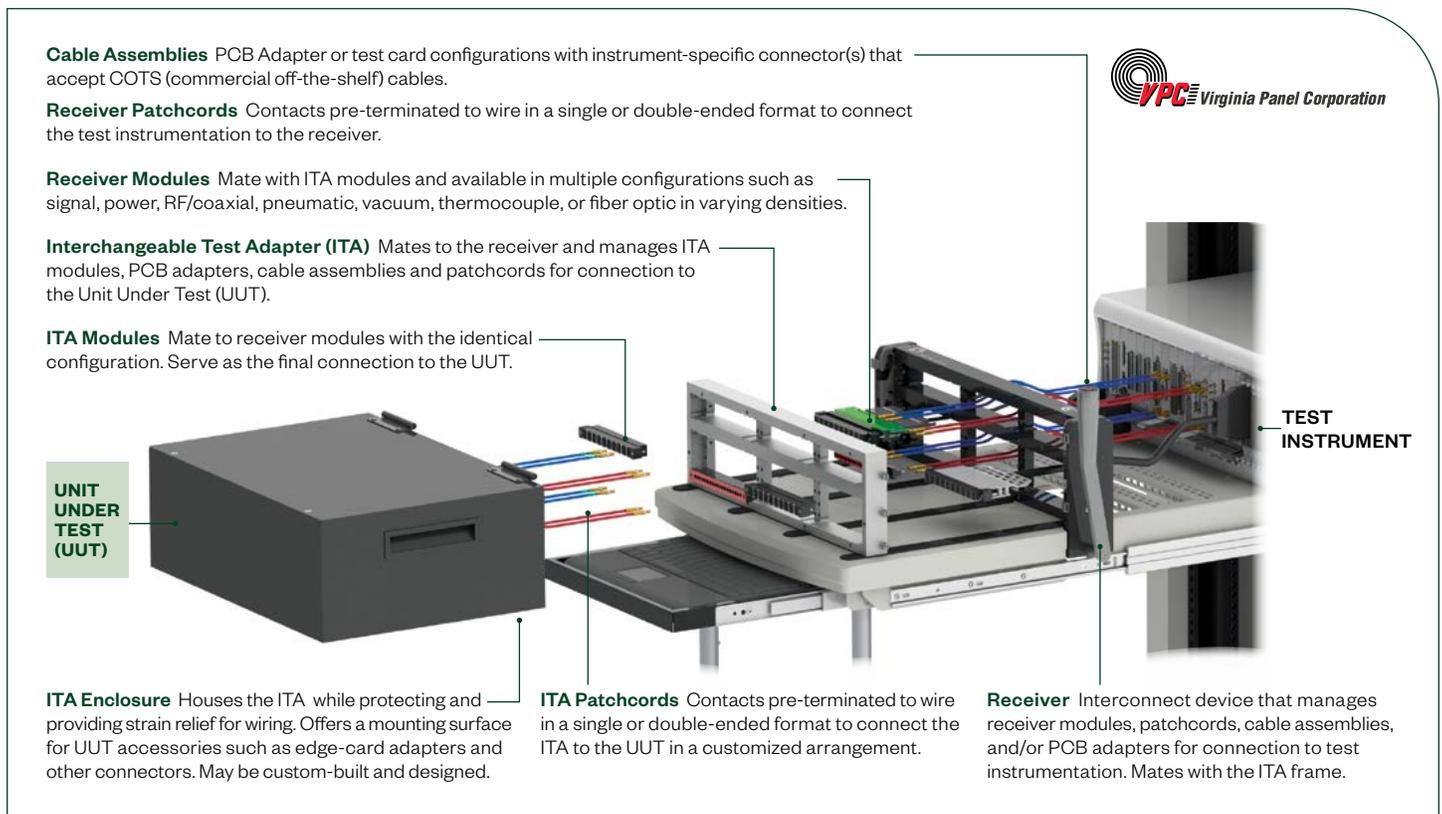


FIGURE 02

Anatomy of a VPC Mass Interconnect

### Why VPC?

- Protect and extend the life of expensive test equipment
- Increase throughput by quickly and easily adapting tester to multiple UUTs
- Utilize both standard and customized solutions to meet your specific needs
- Take advantage of a dedicated team of engineers to help you design and meet your system requirements
- Enjoy simplified cable and patchcord management
- Achieve wiring configuration for virtually any type of test and measurement instrumentation

# Power Electronics Test

Power sources and the systems that require electrical power are growing exponentially in aerospace and defense applications. Whether it's the move from fluid to electronic actuation or fossil fuel to electric propulsion, or the proliferation and increased complexity of satellite technology, generation, distribution, and storage systems need to be tested both individually and when interconnected with other systems.

## Customer Needs

01

Testing complex control systems necessary to manage modern power electronics

02

Testing power systems from low-level board electronics through assembly into subsystems and final integration

03

Using power and heat to test modern power electronics

## NI Solution

01

Interoperable software platforms, high-performance digital interfacing, and application-specific signal conditioning facilitate a modular, platform-based test approach

02

Ample signal conditioning, load, and external power supply offerings ensure easy complex power electronics test

03

A flexible test platform combined with high-performance power electronics provides industry-leading power level test solutions to help you increase productivity and system insight and decrease total cost of test

The system's modular design offers the highest performance, with superior levels of scalability and upgradability. This framework reduced our software development, testing, and integration efforts by 70 percent.

Balaji PK  
Moog India Technology Center

# Case Study: Collins Aerospace Selects NH Research Test Solutions for The Grid Electric Power Systems Lab

NH Research (NHR), a global leader in power test solutions acquired by NI in 2021, was selected by Collins Aerospace to provide electrification test solutions for The Grid electric power supply systems lab in Rockford, Illinois.

Collins Aerospace is investing \$50 million to create the industry's most advanced laboratory for testing high-power electrical components and systems to redefine the future of electric flight.

The 9300 test platform from NHR is ideal for testing aerospace and electric flight applications. It provides innovative battery emulation capability, flexibility to address today's higher voltage levels, and modularity to expand to future requirements.

- Scalable from 100 kW to 2.4 MW
- Wide operating envelope
- Dual voltage ranges
- Submillisecond rise time



At NHR, we focus on developing world-class test solutions that enable electrification. We are proud to be selected as a key partner by Collins in redefining aerospace. This revolutionary development lab will advance and accelerate technology development by enabling test capability for high-power and high-voltage designs. We are excited to help achieve this vision with our advanced test solutions and dedicated support team.

**Pete O'Brien**  
Vice President of Sales and Marketing, NH Research

# Electronics Manufacturing Test Hardware

## Analog



### Digital Multimeter

PXI Digital Multimeters, or DMMs, feature AC/DC voltage, AC/DC current, 2- or 4-wire resistance, and frequency/period measurements, as well as diode tests. You can choose a PXI DMM with an isolated, high-voltage digitizer that can acquire waveforms at sample rates of up to 1.8 MS/s at full input range, up to 3 A or 1,000 V. Additionally, you can choose a PXI DMM that can perform basic inductance and capacitance measurements.



### Multiplexer Switch

PXI Multiplexer Switch Modules are ideal for high-channel-count applications that require connecting measurement or signal generation instruments to various test points on DUTs or UUTs. These modules use a variety of relay types, including electromechanical armature relays, reed relays, field-effect transistor (FET) relays, and solid-state relays, each with its own benefits—so you can choose a multiplexer that fits your requirements.



### Switch Matrix

PXI Matrix Switch Modules are organized into rows and columns and provide maximum flexibility for switching systems so that you can connect any channel to any other channel. They use a variety of relay types, including electromechanical armature relays, reed relays, FET relays, and solid-state relays, each with its own benefits—so you can choose a matrix that fits your TPS requirements.



## Programmable Power Supply

PXI Programmable Power Supplies feature multiple channels that you can combine for higher voltage or current capabilities. Some modules include isolated channels and an output-disconnect functionality so that you can isolate from the DUT when not in use and remotely sense to correct for losses in system wiring.



## Source Measure Units

PXI Source Measure Units (SMUs) provide high-precision source and measure capability with features designed to reduce test time and increase flexibility. These features include high channel density for building parallel SMU test systems, deterministic hardware sequencing for minimizing software overhead, and high-speed update and sample rates for quickly changing setpoints and acquiring data. Additionally, with the flexible sample rate and streaming capability of PXI SMUs, you can use the instrument as a digitizer to capture transient behavior, and the digital control loop gives you the ability to adjust the transient response of the instrument to reduce the settling time and minimize overshoot and oscillations.



## Oscilloscopes and Digitizers

PXI Oscilloscopes and PXI Digitizers are flexible, software-defined instruments that are versatile enough for both time- and frequency-domain measurements. They feature up to 8 channels that can sample at speeds up to 12.5 GS/s with 5 GHz of analog bandwidth. You can synchronize multiple oscilloscopes with other instruments at picosecond-level accuracy for high-channel-count and mixed-signal applications.

# Digital



## High-Speed Serial

PXI High-Speed Serial Instruments include a user-programmable FPGA with access to multigigabit transceivers to implement various standard and custom high-speed serial protocols. They are programmable in LabVIEW FPGA for maximum application-specific customization and reuse. PXI High-Speed Serial Instruments also benefit from PXI clocking, triggering, and high-speed data movement capabilities, including streaming to and from disk as well as peer-to-peer streaming. These devices are ideal for high-speed communication protocols such as Serial RapidIO,<sup>®</sup> Fire Channel, ARINC-818, and more.



## Digital Reconfigurable I/O

PXI Digital Reconfigurable I/O Modules feature a user-programmable FPGA for onboard processing and flexible I/O operation. You can completely control the synchronization and timing of all signals and operations along with custom onboard decision making. The PXI Digital Reconfigurable I/O Module is suited for a wide variety of single-ended applications, such as high-speed waveform generation, custom communications protocols, bit error rate testing, and other applications requiring precise timing.



## FlexRIO

PXI FPGA Modules for FlexRIO offer large onboard FPGAs for signal processing. You can pair the module with a Digital I/O Adapter Module for FlexRIO, which offers up to 54 channels of configurable digital I/O that can interface with single-ended, differential, and serial signals at a variety of voltage levels.



## Avionics Communications Buses

PXI Avionics Interface Modules support full-function test, simulation, and operational uses of avionics data buses. With extensive error detection and generation capability, these modules are well-suited for production and system test. They integrate the triggering and system clock features of PXI with MIL-STD1553 and ARINC 429 standards.

# Power, Loads, and Signal Conditioning



## SLSC

SLSC is add-on hardware that integrates with PXI and CompactRIO systems. It standardizes connectivity, minimizes point-to-point wiring, and provides a modular approach to signal conditioning, fault insertion, and other test needs.



## Electronic Loads

Electronic Load Devices can sink power at various current and voltage levels for power-supply design, quality inspection, and functional tests. They feature buttons and knobs for interactive use as well as USB or RS232 interface options for automated use. You can connect multiple loads in parallel to increase your system's overall power capacity.



## Programmable Power Supply

The Programmable Power Supply Device is a single-channel, rack-mount DC power supply. It offers up to 1,500 W of power with options up to 650 V DC or 150 A, so you can use it for test systems that require large amounts of power with a broad range of voltage and current values. Some models can source hundreds of watts in a compact 2U, 1/6 rack-width design, making them ideal for test systems that need multiple power rails. Additionally, the Programmable Power Supply Device offers buttons and knobs for interactive users as well as USB, LAN, RS232, and analog control options for remote or automated users.

# Software Architecture for Electronics Manufacturing Test

Reference solutions for electronics manufacturing test include a combination of PXI modular instruments and measurement, automation, and data and systems management software that provides a balance of customization and reduced time to measurement. NI is the only vendor to offer a full suite of tried-and-tested modular software components, from world-class hardware drivers and integration tools, to code module development environments and test executives, to systems management and MES integration.

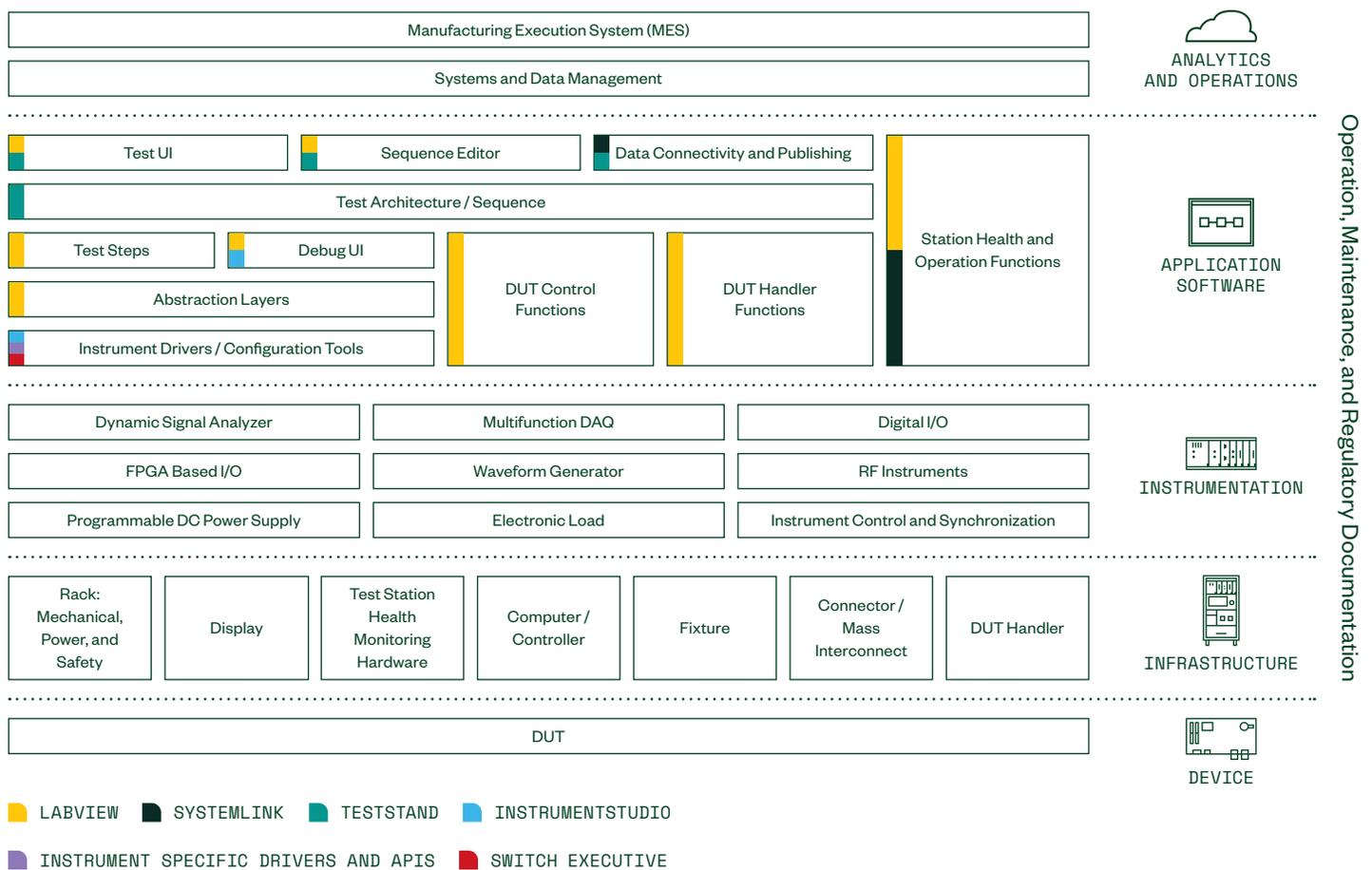


FIGURE 03

Typical TPS Software Architecture of an Electronics Manufacturing Test System

**Instrument-Specific Drivers and APIs**—Quickly and directly control any modular instrument to customize test parameters with instrument-specific drivers and APIs.

**Switch Executive**—Use a point-and-click graphical configuration environment with automatic routing capabilities to easily design your switch system.

**InstrumentStudio Software**—Unify your display, export instrument configurations to code, and monitor and debug your TPS.

**LabVIEW**—Leverage a graphical programming environment that helps you visualize every aspect of your application, including hardware configuration, measurement data, and debugging.

**TestStand**—Optimize test-development times with high-level test executive software for automating complex test sequences written in many development languages.

**SystemLink Software**—Manage tasks such as software deployment, device configuration, health and test monitoring, and data management and visualization.

## Instrument-Specific Drivers and APIs

NI measurement driver software includes best-in-class APIs that work with a variety of development options, including LabVIEW, C, C#, and Python. To ensure long-term interoperability of NI instruments, the driver APIs are the same APIs used for all past and current instruments. The driver software also provides access to help files, documentation, and dozens of ready-to-run shipping examples you can use as a starting point for your application.

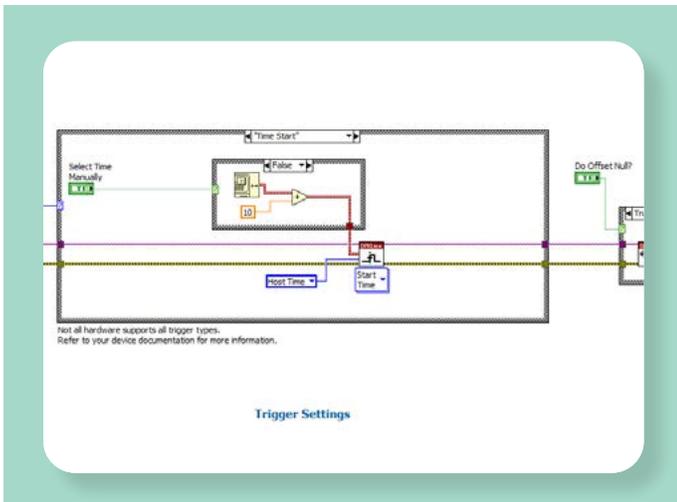


FIGURE 04  
LabVIEW API for NI-DAQmx

```
// DAQmx analog voltage channel and timing
parameters

DAQmxErrChk (DAQmxCreateTask("", &taskHandle));

DAQmxErrChk(DAQmxCreateAIVoltageChan(taskHandle,
"Dev1/ai0", "", DAQmx_Val_Cfg_Default, -10.0,
10.0, DAQmx_Val_Volts, NULL));

DAQmxErrChk(DAQmxCfgSampClkTiming(taskHandle,
"", 10000.0, DAQmx_Val_Rising, DAQmx_Val_
FiniteSamps, 1000));

// DAQmx Start Code

DAQmxErrChk(DAQmxStartTask(taskHandle));
// DAQmx Read Code

DAQmxErrChk(DAQmxReadAnalogF64(taskHandle,
1000, 10.0, DAQmx_Val_GroupByChannel, data,
1000, &read, NULL));
// Stop and clear task
```

FIGURE 05  
C API for NI-DAQmx

# Switch Executive Application Software

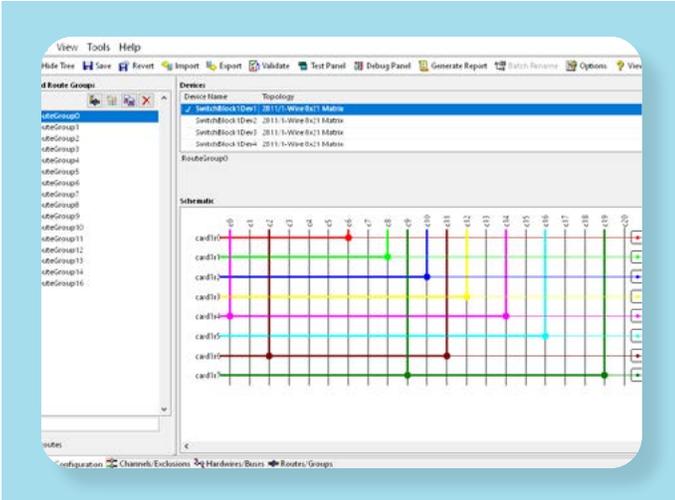


FIGURE 06

Switch Executive is a point-and-click graphical configuration environment with automatic routing capabilities, making it easy to design your switch system.

- Graphically configure routes and route groups
- Develop reusable switching code and integrate it into TestStand or LabVIEW
- Automatically route signals between switch endpoints
- Scale switch configuration using Microsoft Excel
- Maintain switch configuration using route validation, reporting, and debugging features

# InstrumentStudio Software for Interactive Measurements

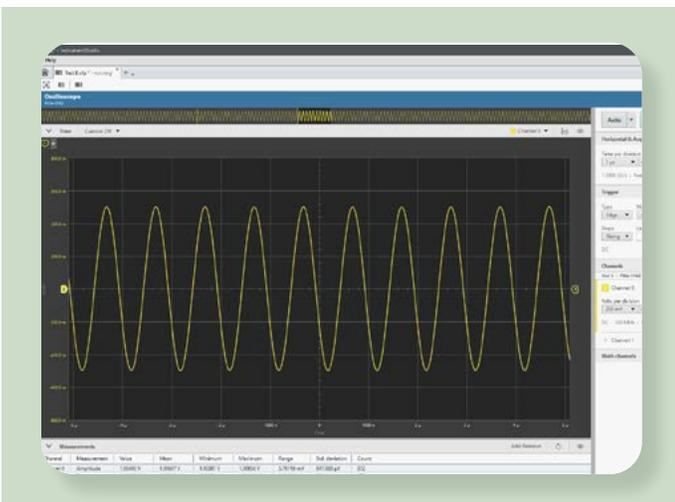


FIGURE 07

InstrumentStudio helps you unify your display, export instrument configurations to code, and monitor and debug your automated test system.

- Integrate your instruments into a single view
- Capture multi-instrument screenshots, measurement results, parameter configurations, and UI layouts for broader insight and instant repeatability
- Export instrument configurations to code
- Guarantee correlation by replicating instrument configurations using a single API function call

# LabVIEW

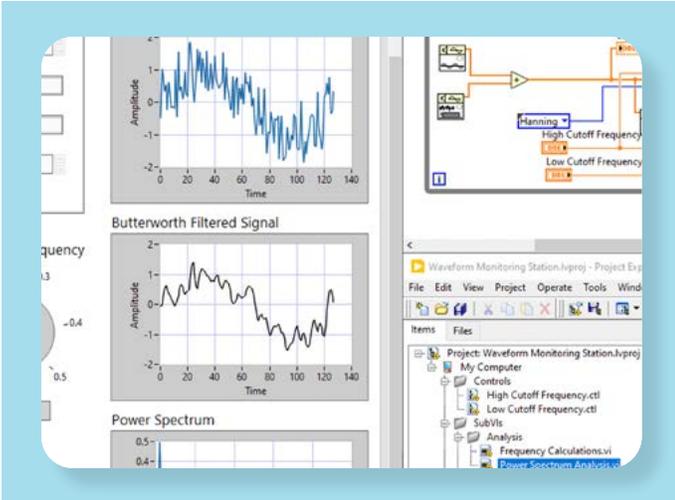


FIGURE 08

LabVIEW reduces the cost of test by helping you stay ahead of the evolving needs of your production test systems with the flexibility to connect to virtually any instrument, reuse existing code, and quickly design user interfaces.

- Reduce system setup with access to thousands of instrument drivers, example programs, and documentation to connect to virtually any modular or traditional box instrument
- Use hundreds of instrument-specific example code modules and included measurement libraries to reduce development time
- Reuse existing code libraries from languages like C/C++/C#, .NET, Python, and MathWorks MATLAB®
- Quickly create professional user interfaces to visualize test outcomes
- Build proficiency with extensive online and in-person training options for both new users and certified architects in NI tools.

# TestStand

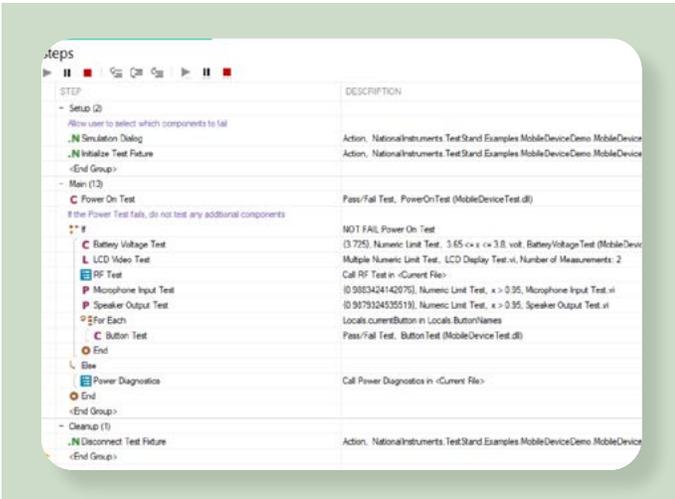


FIGURE 09

TestStand is ready-to-run test management software that is designed to help you quickly develop and execute TPS software.

- Customize test sequences to meet every requirement
- Automate saving and reporting test data
- Increase test throughput with parallel testing
- Efficiently replicate and deploy test systems
- Troubleshoot test systems with integrated debugging tools
- Customise user interfaces to meet testing needs

# SystemLink

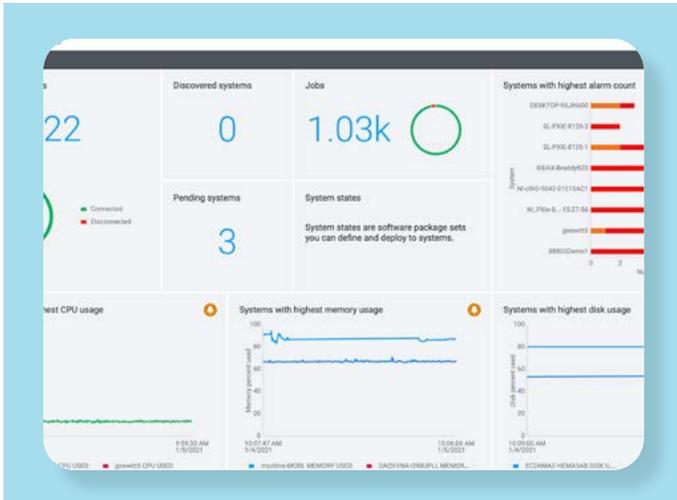


FIGURE 10

Improve systems and data management processes with powerful, intuitive web applications and an open, extensible software architecture.

- SystemLink's Software Configuration Module enables test organizations to achieve operational excellence with central coordination of test and measurement systems.
- SystemLink's Asset Module connects testers together for real-time monitoring & alerting, optimized utilization, centralized configuration management, and predictive maintenance.
- SystemLink's Test Module collects and processes test data, enabling analytics and visualizations for actionable insights from test systems, test results, and associated engineering data.
- The SystemLink TDM DataFinder Module enables test organizations and product validation teams to efficiently manage, search, access, and analyze all measurement data.



---

## System Integration on Your Terms

NI offers a variety of solution integration options customized to your application-specific requirements. You can use your own internal integration teams for full system control, or leverage the expertise of our worldwide network of Alliance Partners to obtain a turnkey system.

Contact your account manager or call or email us to learn more about how NI can help you increase product quality and accelerate test timelines at (888) 280-7645 or [info@ni.com](mailto:info@ni.com).

---

## NI Services and Support



Consulting and Integration



Turnkey Solution Delivery and Support



Repair and Calibration



Global Support



Prototyping and Feasibility Analysis



Training and Certification

[ni.com](http://ni.com)  
[ni.com/aerospace](http://ni.com/aerospace)

